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H2E

(71) Applicant
Yamaichi Electric Mfg Co Ltd (Japan),
8–16 Chidori 2-chome, Ohta-ku, Tokyo, Japan

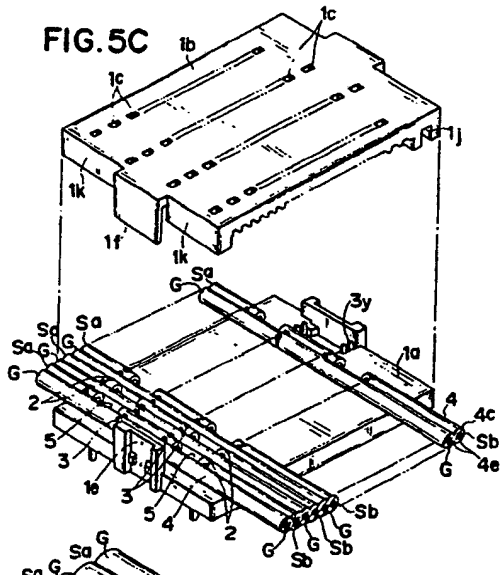
(72) Inventors
Motoki Kosugi
Hidetaka Nakano

(74) Agent and/or Address for Service
Michael Burnside & Partners,
2 Serjeants' Inn, Fleet Street, London EC4Y 1HL

(54) Flat cable connecting system

(57) A connector wherein a multiple core flat cable is pinched between a connector cover (1b) and a connector substrate (1a) having insulation-piercing terminals (2,3), is characterised in that perforations (5) divide conductors into conductor segments extending in one direction and conductor segments extending in the other direction from the perforation, and respective terminals (2,3) of the connector substrate (1a) are connected to respective conductor segments at each side of a perforation. In the arrangement shown, an intermediate conductor segment between two perforations is grounded, so as to separate two signal conductor segments Sa, Sb of a perforated conductor. In other arrangements a single perforation in a conductor may separate two signal segments, or one segment may be grounded, or one segment may not be connected to signal or earth. Ground conductors G may be intact and connected to respective intermediate conductors.

FIG.5C



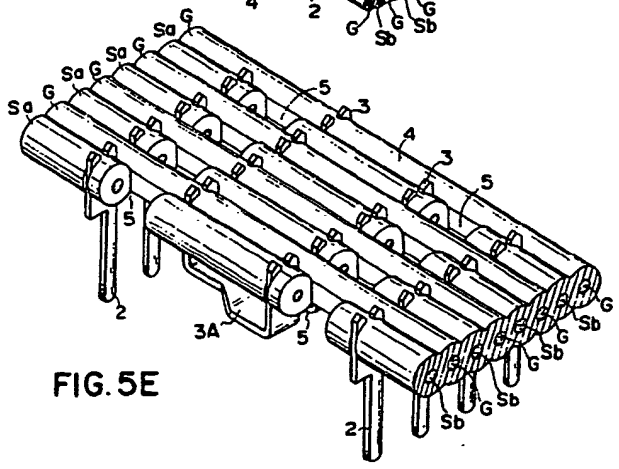


FIG.5E

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FIG.1

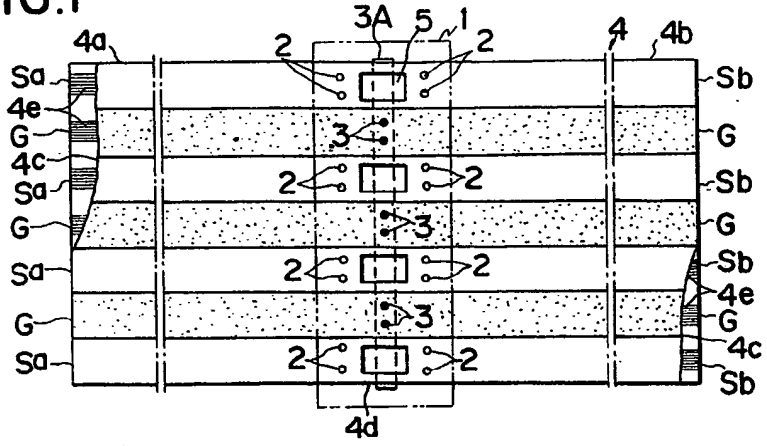


FIG.2

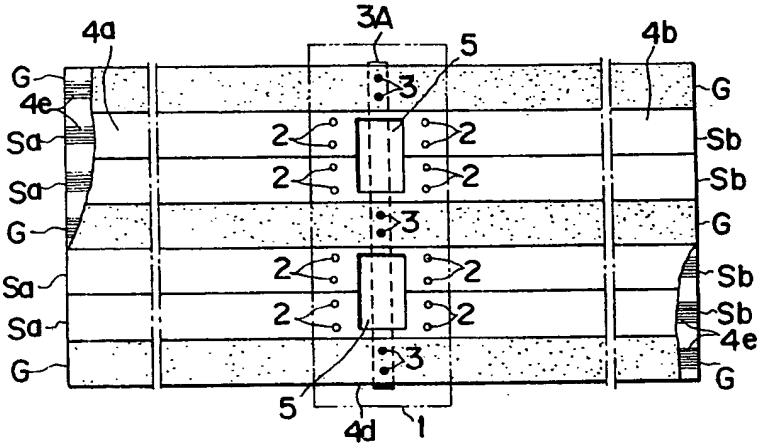


FIG.3

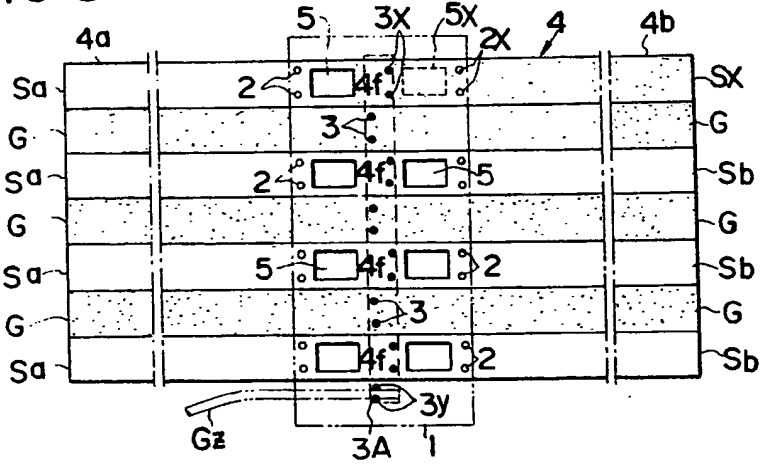


FIG. 4

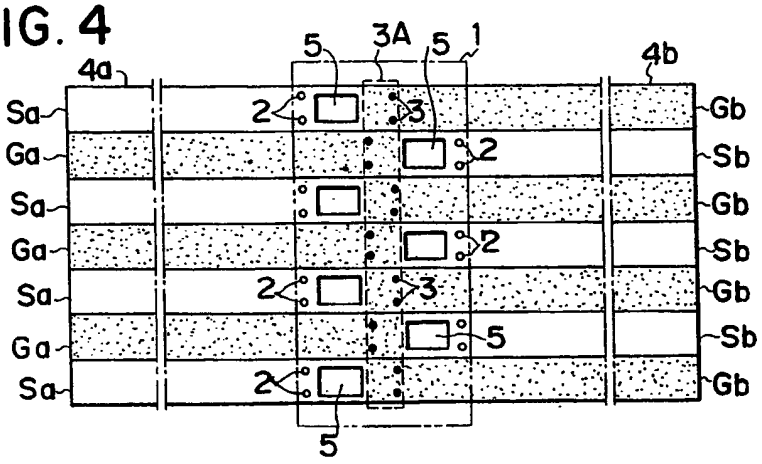

4a
5
3A
5
1
4b
Sa
Ga
Sa
Ga
Sa
Ga
Sa
Gb
Sb
Gb
Sb
Gb
Sb
Gb
2
3
2
2
2
3
5
2
5

FIG. 5A

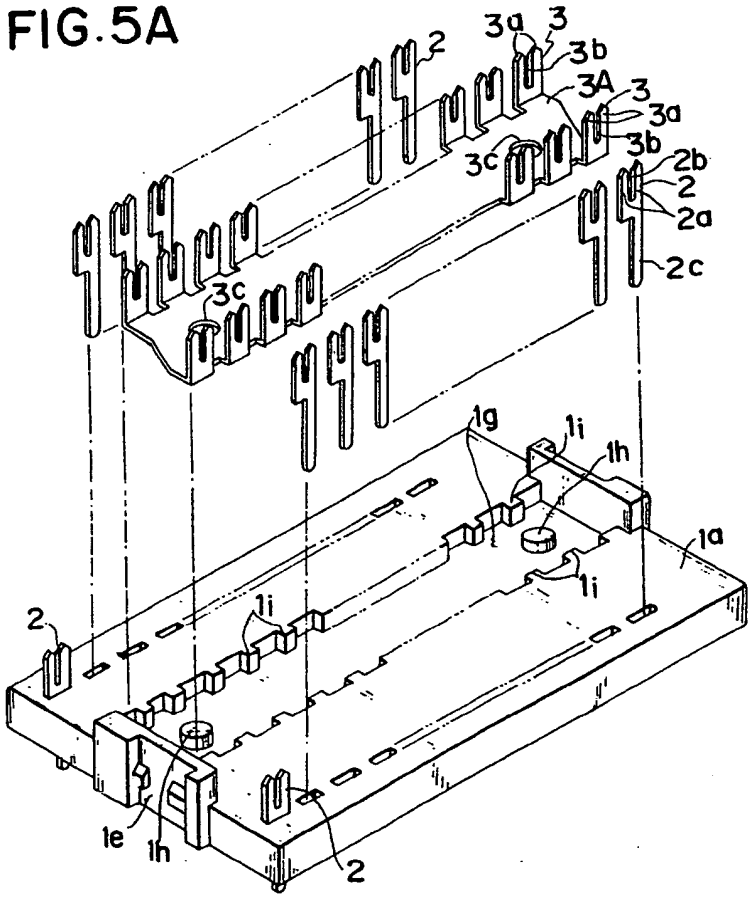

2
3a
3
3b
3A
3
3a
3b
3c
2b
2
2a
2c
3c
1g
1i
1h
1a
1i
2
1i
1e
1h
2

FIG. 5B

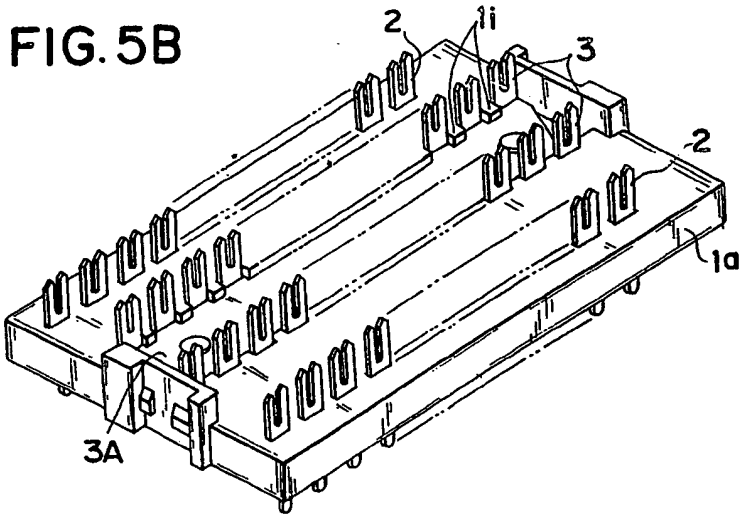

2
1i
3
2
1a
3A

FIG. 5C

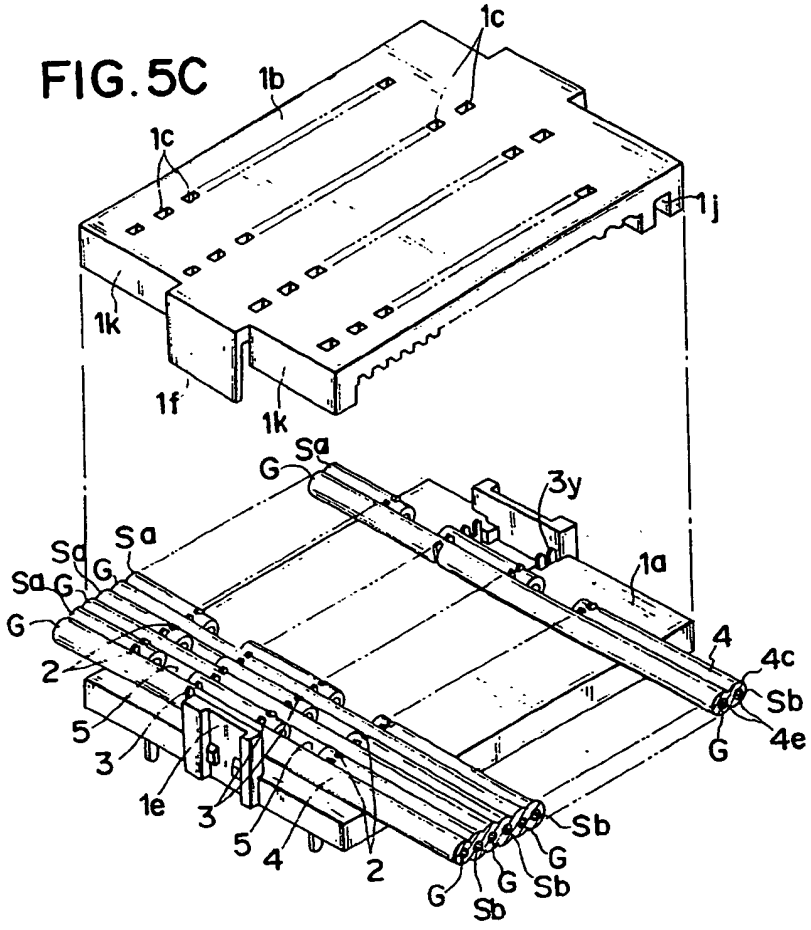

1c
1b
1c
1j
1k
1f
1k
Sa
G
3y
Sa
Sa
G
G
Sa
G
1a
4
4c
Sb
4e
G
2
5
3
1e
3
5
4
2
Sb
G
G
Sb
G
Sb

FIG. 5D

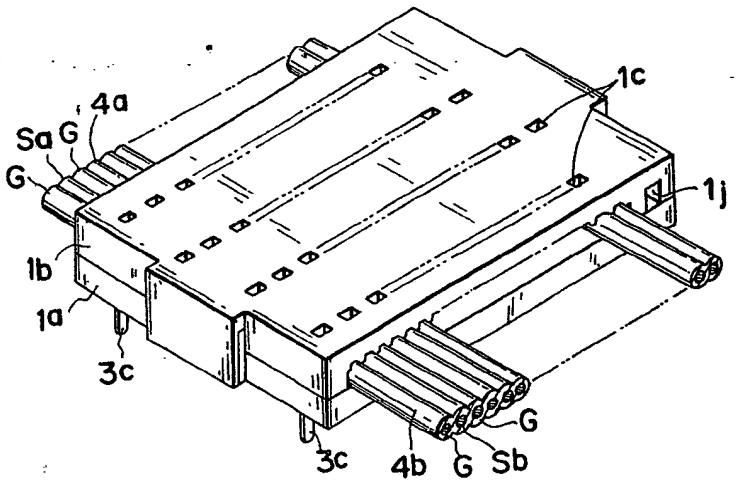

1c
4a
Sa
G
G
1j
1b
1a
3c
G
3c
4b
G
Sb

FIG. 5E

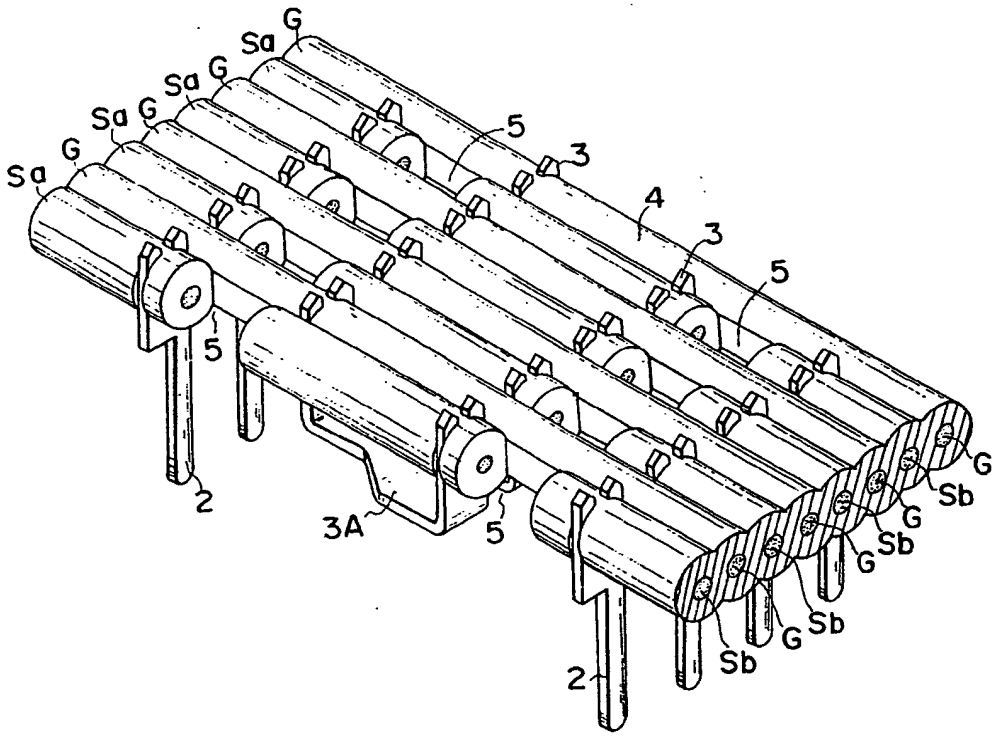

G
Sa
G
Sa
G
Sa
G
Sa
5
3
4
3
5
5
2
3A
5
G
Sb
G
Sb
G
Sb
G
Sb
2

FIG. 6

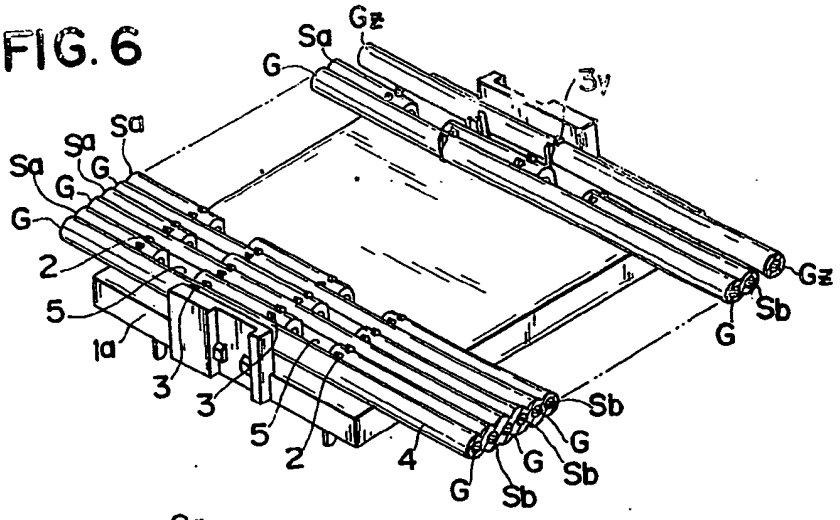


FIG. 7

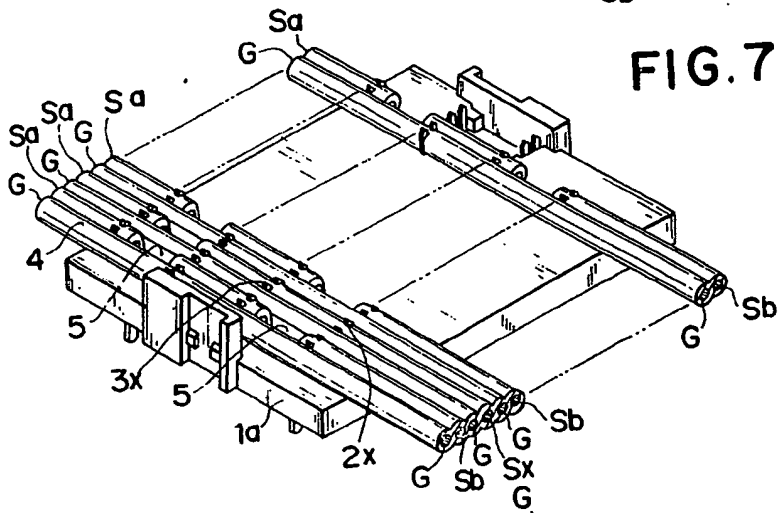


FIG. 8A

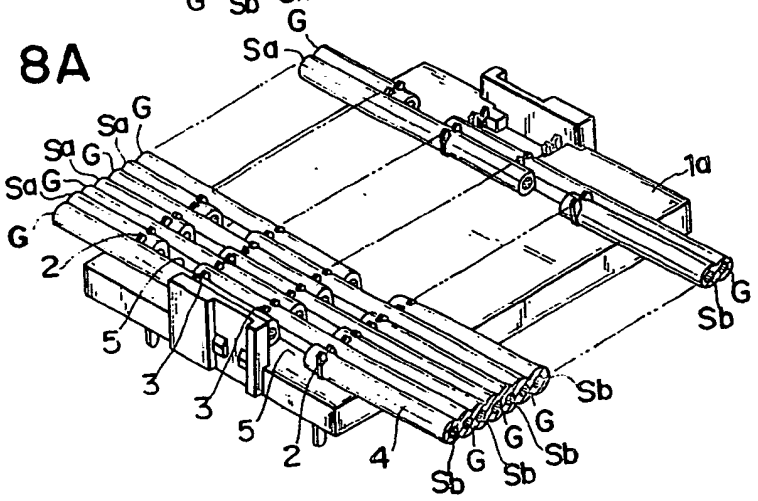


FIG. 8B

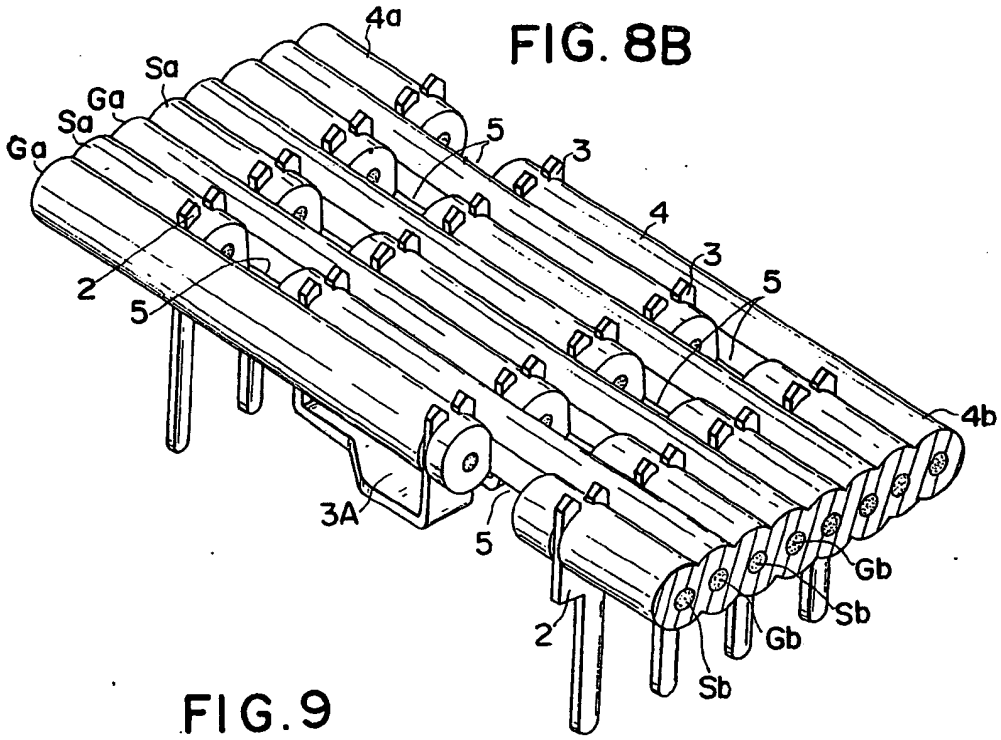


FIG. 9

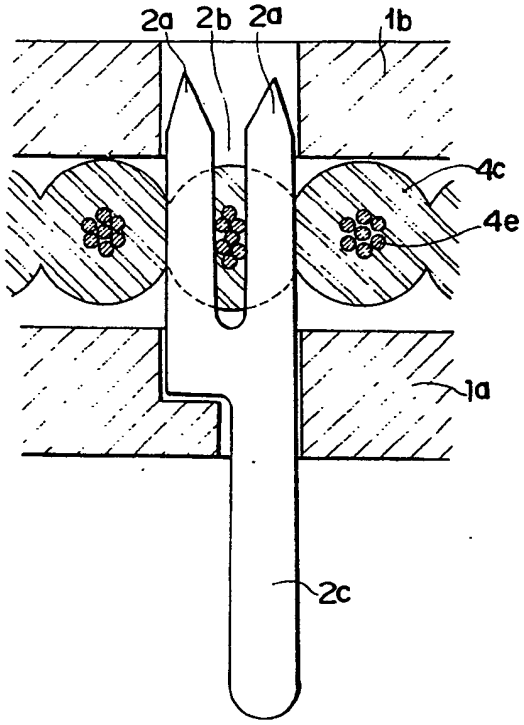


FIG. 10A

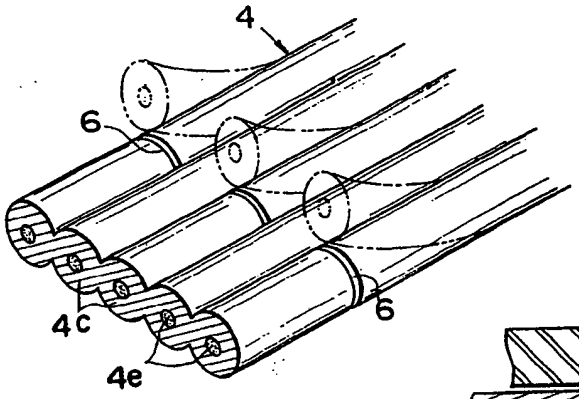


FIG. 10B

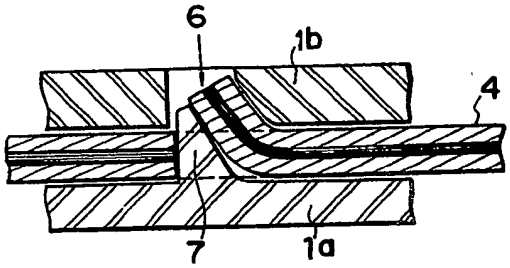


FIG. 11

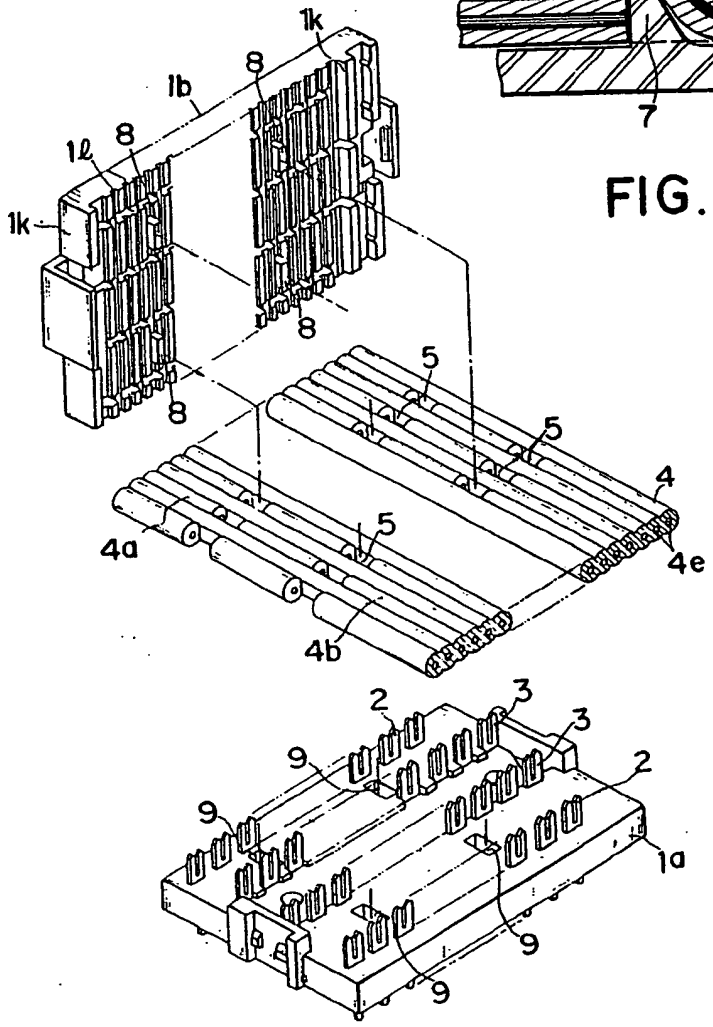


FIG. 12

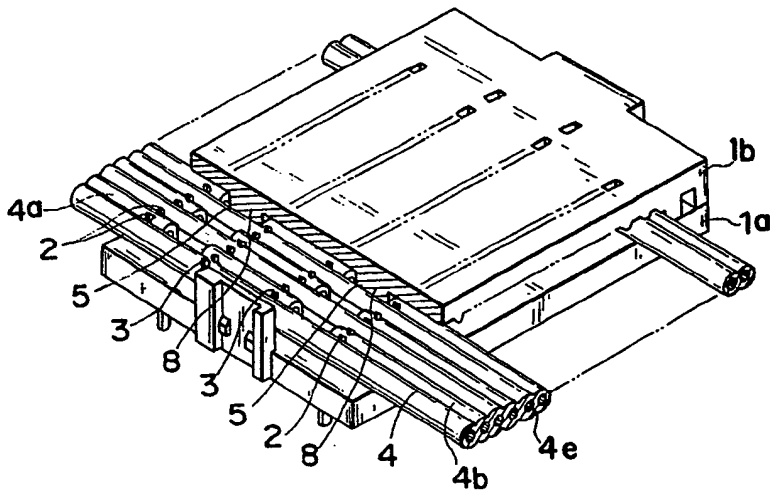


FIG. 13

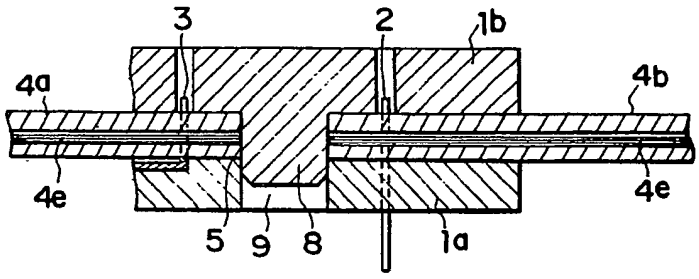


FIG.14

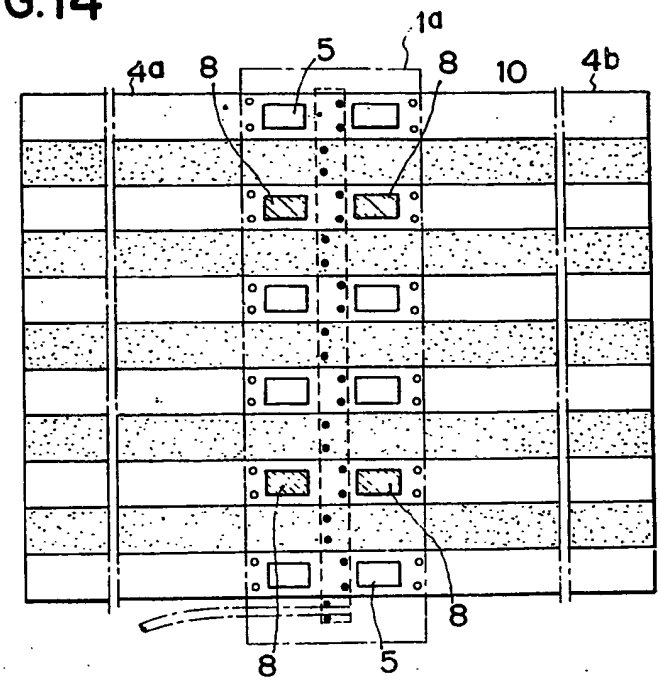

1a
4a
8
5
8
10
4b
8
8
5

FIG.15

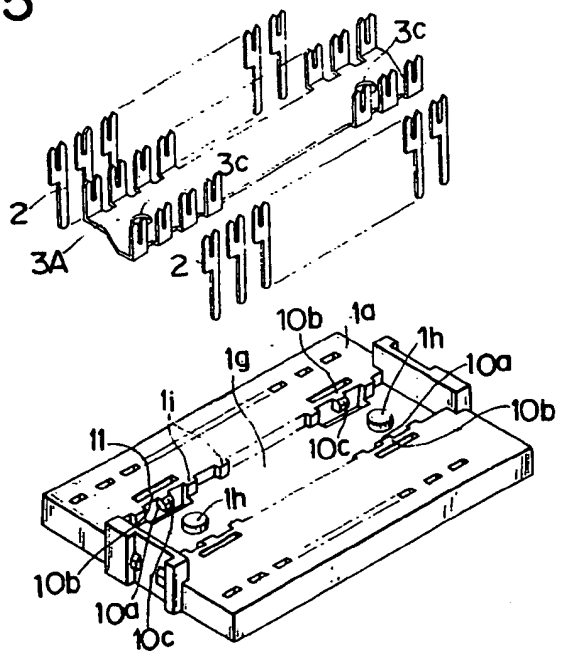

3c
3c
2
3A
2
10b
1a
1h
1g
10a
1i
10b
11
10c
1h
10b
10a
10c

FIG. 16

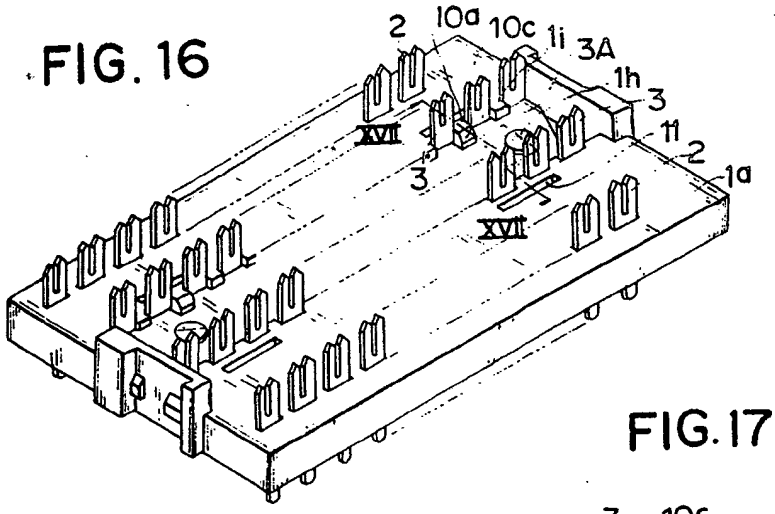


FIG. 17

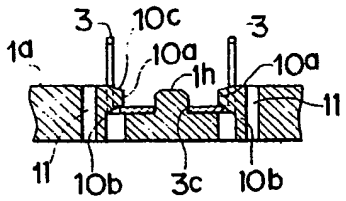


FIG. 18

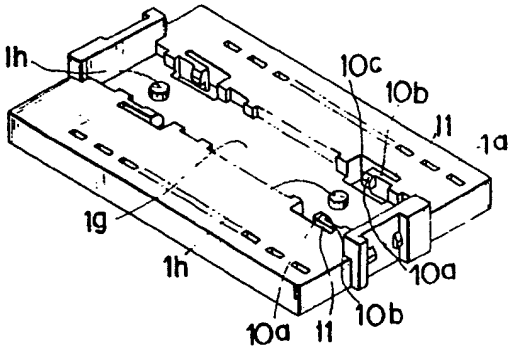
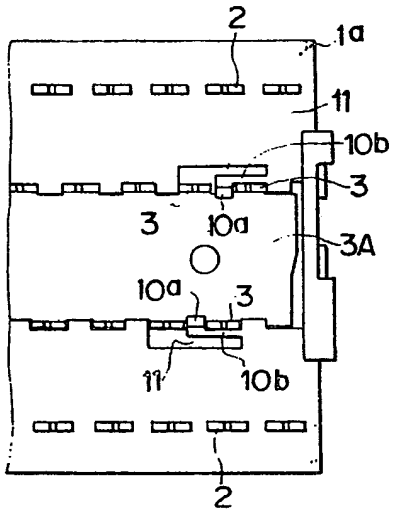


FIG. 19



SPECIFICATION

Flat cable connecting system

The present invention relates to a system for the connection of a multiple core flat cable to which a connector having a plurality of contacts is attached so that the contacts may pierce through an insulator of the flat cable to catch hold of and connect the conductors in the insulator.

The term "multiple core flat cable" used throughout the specification means a cable having a number of parallel conductors coated with a strap of insulator and having a flat portion formed on at least part of the entire length thereof and includes, for example, ribbon-shaped flat cables each having a plurality of conductors arranged in parallel and coated with a strap of insulator over the entire length thereof and twisted flat cables each comprising a number of twisted conductor pairs arranged in series and having an insulated connector-fitting area to be subjected to electrical connection after each conductor pair has been untwisted to be aligned in parallel. The multiple core flat cable finds wide acceptance in forming a number of signal lines by connecting its conductors one each to contacts for signal of a connector.

It has been known that the construction of a number of conductors of a flat cable composed of those for signal and those for earthing being alternately arranged adjacent to each other can prevent electrical interference between the conductors for signal, i.e. cross talk, and can therefore make electrical transmission characteristics of the conductors for signal good. When a flat cable has conductors for earthing and conductors for signal arranged alternately, as described above, the number of the conductors for signal becomes one half the entire number of the conductors of the flat cable. Therefore, in order to secure both the conductors for earthing serving to prevent the aforementioned cross talk and the number of conductors for signal corresponding to the entire number of a strap of flat cable, it has been required to prepare two straps of flat cables and to provide individual connection mechanisms and connection operations of the flat cables.

An operation for establishing a circuit having signal lines and earthing lines with the two straps of flat cables is very troublesome and entails much time and labor and further calls for an increase in exclusive space for the connection mechanism. This runs counter to the recent demands for miniaturization and simplification of a device.

The main object of the present invention is to provide a flat cable connecting system capable of forming different signal lines on one and the other sides of a continuous strap of flat cable without use of two straps of flat cables as required in the prior art and forming earthing lines adjacent to the signal lines, and capable of constructing aimed lines with a connection operation as simple as that heretofore required for attachment of a single connector to the terminal of a single flat cable.

To attain the object described above, according to the present invention, there is provided a system for connecting a multiple core flat cable by pinching the flat cable between a connector cover and a connector substrate having contacts to cause the contacts to pierce through an insulator of the flat cable and, in conjunction therewith, to catch hold of and electrically connect conductors within the insulator, which system comprises forming in the insulator of the flat cable perforations for dividing the conductors into conductor segments extending to one direction and conductor segments extending in the other direction, and causing the contacts for different signals to catch hold of and connect the respective conductor segments at terminals of the respective conductor segments on the perforation sides to thereby form different signal lines with the perfforations as boundaries.

The aforementioned object, other objects, characteristic features and advantages of the present invention will become apparent from the further description of the invention which is given hereinbelow with reference to the accompanying drawings, in which:

FIG. 1 is an explanatory, schematic plan view showing the relation between a flat cable and contacts of one fundamental embodiment according to the present invention.

FIG. 2 is an explanatory, schematic plan view showing one modification of the embodiment of FIG. 1.

FIG. 3 is an explanatory, schematic plan view showing another modification of the embodiment of FIG. 1.

FIG. 4 is an explanatory, schematic plan view showing the relation between a flat cable and contacts of another fundamental embodiment according to the present invention.

FIGS. 5A, 5B, 5C, 5D and 5E show one example of the modification of FIG. 4, FIG. 5A being an exploded perspective view of a connector substrate, FIG. 5B being a perspective view of the connector substrate in an assembled state, FIG. 5C being an exploded perspective view showing the connector substrate, a connector cover and a flat cable in a state assumed before assemblage, FIG. 5D being a perspective view showing the connector substrate, connector cover and flat cable in an assembled state, and FIG. 5E being an enlarged perspective view showing the state of connection between the flat cable and the contacts.

FIG. 6 shows another example of the modification of FIG. 3 and is a perspective view showing a connector and a connection mecha-

nism provided with one common earth bus bar.

FIG. 7 shows still another example of the modification of FIG. 3 and is a perspective view showing a connector and a connection mechanism provided with another common earth bus bar.

FIGS. 8A and 8B show a modification of the embodiment of FIG. 4, FIG. 8A being a perspective view showing a connector and a connection mechanism and FIG. 8B being an enlarged perspective view showing the state of connection between the flat cable and the contacts.

FIG. 9 is an enlarged cross-sectional view showing the construction of a contact for signal in its connected state.

FIGS. 10A and 10B show a flat cable having cut slits, FIG. 10A being an enlarged perspective view showing an example for forming the cut slits in the flat cable and FIG. 10B being a cross-sectional view showing the state of the flat cable attached to the connector.

FIG. 11 is an exploded perspective view showing still another embodiment of the present invention, wherein a connector is provided with positioning keys and positioning apertures and is in a state assumed before pressure connection with a multiple core flat cable.

FIG. 12 is a partially cut-away perspective view showing the state assumed when the flat cable has been pinched between the connector cover and the connector substrate.

FIG. 13 is a longitudinal cross section showing the connector cover, multiple core flat cable and connector substrate in a state assumed when the positioning key of the connector cover has been inserted and fitted in the perforation for dividing the conductor.

FIG. 14 is a schematical plan view showing a pattern of perforations and the pressure connection state and the key fitting state obtained in accordance with the pattern.

FIG. 15 is an exploded perspective view showing a connector substrate provided with engaging claws for firmly attaching a common earth bus plate thereto.

FIG. 16 is a perspective view showing the conductor substrate in its assembled state.

FIG. 17 is a cross-sectional view takes along the line XVII-XVII in FIG. 16.

FIG. 18 is a perspective view showing a connector substrate provided with other engaging means for firmly attaching the common earth bus plate thereto.

FIG. 19 is a plan view showing the principal part of the connector substrate in a state assumed when the common earth bus plate of the contacts for earthing has been attached.

FIG. 1 shows one of the fundamental embodiments according to the present invention, in which patterns of perfforations, signal lines and earthing lines are formed. FIGS. 2 and 3 show modifications of the fundamental embodiment in FIG. 1. FIG. 4 shows another fundamental embodiment according to the present invention. These Figures are schematically drawn for the purpose of explaining the fundamental ideas of the present invention.

FIG. 5A through FIG. 5E show one typical example of the idea of FIG. 3 materialized to put the flat cable connecting system to practical use and FIG. 8 shows one typical example of the idea of FIG. 4 materialized and, therefore, FIGS. 5 to 8 should be referred to in conjunction with FIGS. 1 to 4. In these Figures, the same elements are identified by the same reference numerals.

Reference numeral 1 denotes a connector, 2 contacts for signal provided on the connector, 3 contacts for earthing provided on the connector, and 4 a multiple core flat cable to be connected to the connector. All contacts 3 for earthing are integrally formed with and rise from a common earth bus plate 3A and all contacts 2 for signal are independently planted in a connector substrate 1a.

To facilitate the understanding of FIG. 1 through FIG. 4, the flat cable 4 is shown to have a small number of cores, the contacts 2 for signal and the contacts 3 for earthing are shown respectively by blank and solid circles, and conductors for earthing are shown by use of satin patterns to distinguish themselves from conductors for signal. Concrete constructions of these elements are shown in detail in FIG. 5A et sequentes.

The connector 1 is attached to the flat cable 4 in its connector-fitting area 4d midway the lengthwise direction in any of FIG. 1 through FIG. 4. The flat cable 4 has a number of parallel conductors 4e arranged at regular intervals and extended within a strap of insulator 4c. The insulator 4c of the flat cable 4 has a plurality of perforations 5 bored in the connector-fitting area 4d to partially or entirely disconnect the conductors.

The perforations 5 in any of the embodiments described above are formed by cutting off (punching with a press) the insulator 4c and the conductors 4e at a certain area in the lengthwise direction. Optionally, the perforations may be formed by cutting slits 6 and penetrating insulating spacers 7, which rise up from the connector substrate 1a or down from the connector cover lb, into the cut slits 6 as shown in FIGS. 10A and 10B.

Thus, part or all of the conductors are disconnected by the perforations 5 piercing through the insulator 4c as extended within the insulator 4c to divide the conductors into conductor segments 4a and conductor segments 4b which are extended respectively toward one and the other ends of the flat cable 4 with the perforations 5 as the centers.

The one directional conductor segments 4a, the other directional conductor segments 4b and imperforate conductors are caught by and

connected to the contacts 2 for signal and/or contacts 3 for earthing of the connector 1 attached to the connector-fitting area 4d of the flat cable 4. As a result, two-directional signal lines having conductors Sa and Sb which are separate from each other by the perforations 5 developed by the patterns shown in FIGS. 1 to 3 or FIG. 4 are established.

It is thus made possible to form different signal lines on the opposite sides of a single strap of flat cable 4 and simultaneously to form patterns composed of the conductors Sa for signal and conductors G for earthing which are adjacent to each other on one side and the conductors Sb for signal and conductors *G* which are adjacent to each other on the other side of the flat cable, and composed of the conductors Sa for signal and conductors Ga for earthing which are adjacent to each other on one side and the conductors Sb for signal and conductors Gb for earthing which are adjacent to each other on the other side of the flat cable, as illustrated in FIGS. 1 to 4.

The contacts 2 and 3 for signal and earthing, which have a construction such that they can pierce through the insulator 4c and firmly pinch the conductor within the insulator, are used and are spear-like forked contacts as shown in FIG. 9, for example. The contacts 2 and 3 shown respectively by the blank and solid circles in FIGS. 1 to 4 are of such type as the aforementioned spear-like forked contacts.

Each of the contacts 2 for signal comprises at least one pair of parallel prongs 2a having sharp leading ends, a U-shaped slot 2b defined between the prongs, and a male terminal 2c perpendicularly extending downwardly from the lower ends of the prongs 2a and being planted into the connector substrate 1a so that the male terminal 2c projects downwardly and the prongs 2a project upwardly relative to the connector substrate. Each of the contacts 3 for earthing has at least one pair of prongs 3a having sharp leading ends and defines a U-shaped slot 3b between the prongs, and the lower ends of the prongs 3a of all contacts 3 for earthing are integrally connected to a common earth bus plate 3A which is fitted in the center of the connector substrate 1a to allow the prongs 3a to project upwardly of the connector substrate. The contacts 2 for signal and the contacts 3 for earthing are thus arranged in series with the patters as shown in FIGS. 1 to 4.

The aforementioned earth bus plate 3A is firmly attached to the connector substrate la at a prescribed position by fitting itself in a concave portion 1g formed in the center of the connector substrate between two rows of the contacts 2 for signal in the direction of the width of the flat cable, fitting mounting holes 3c in the earth bus plate 3A under pressure around projections 1h formed on the bottom wall of the concave portion 1g of the connector substrate 1a and at the same time interposing between the spaces of the adjacent contacts 3 for earthing rack protuberances 1i formed on the right and left side walls of the concave portion 1g of the connector substrate la in the direction of the width of the flat cable at the same pitch as that of the contacts 3 for earthing.

FIG. 15 to FIG. 19 disclose means for firmly attaching the common earth bus plate 3A to the connector substrate 1a with ease. At the positions at which the aforementioned rack protuberances 1i are disposed, i.e. on the side walls of the concave portion 1g of the connector substrate, there are formed engaging claws 10a which are to be interposed between the contacts 3 for earthing and engaged with the upper surface of the bus plate 3A at the edges thereof and which are carried on elastically shiftable engaging pieces 10b formed integrally with the connector substrate 1a. The engaging claw 10a is projected integrally from the front surface of the engaging piece 10b so that it may engage with the upper surface of the edge of the bus plate 3A by utilization of the elastic deformation or shift of the engaging piece 10b.

In FIG. 15 to FIG. 17, the engaging piece 10b is laterally disposed along the side wall of the concave portion 1g (along the direction in which the contacts 3 for earthing are arranged in rows) with its opposite ends connected to the connector substrate 1a and is provided on the front surffface thereof at its center integrally with the projecting engaging claw 10a which has a tapered portion 10c. The earth bus plate 3A pushes away the tapered portion 10c of the engaging claw 10a and, at this time, the engaging piece 10b is elastically shifted in the backward direction (in the direction against the elasticity) to allow the earth bus plate 3A to be fitted in the concave portion 1g. As soon as the earth bus plate 3A has been fitted in the concave portion 1g, the engaging piece 10b is restored by virtue of its own elasticity to allow the engaging claw 10a to be interposed between the contacts 3 and engaged with the upper surface of the edge of the bus plate. The connector substrate 1a has oblong holes 11 formed in the portions in front of and behind the engaging pieces 10b so as to facilitate the elastic deformation or shift of the engaging pieces 10b. The formation of the oblong holes 11 allows the engaging piece 10b to be connected to the connector substrate 1a at the opposite ends only.

In FIGS. 18 and 19, the engaging piece 10b is laterally disposed to have its one end connected to the connector substrate 1a and its other end made free and has the engaging claw 10a projected from the front surface of the free end, whereby the elastic deformation or shift of the engaging piece and the engagement of the engaging claw with the upper

surface of the edge of the earth bus plate can be attained similarly to the embodiment shown in FIGS. 15 to 17.

According to the construction shown in FIGS. 15 to 17 and that shown in FIGS. 18 and 19 adopting the common earth bus plate 3A to which the contacts 3 for earthing are integrally connected, as described above, although it is difficult to form such male terminals as those 2c of the contacts 2 for signal on the respective contacts 3 for earthing, the common earth bus plate 3A can precisely be fixed with ease at the prescribed position of the connector substrate 1a and can be prevented from being laterally shifted, floating and shaking.

The connectors and the connecting mechanisms usable in the embodiments shown in FIGS. 1 through 4 will be understood from FIGS. 5 to 7 corresponding to the typical example of FIG. 3 and from FIG. 8 corresponding to a typical example of FIG. 4.

The connector 1 comprises the connector substrate 1a having an insulating disc as a matrix and the connector cover 1b. When the connector substrate 1a and the connector cover 1b are assembled into the connector 1 with the flat cable 4 embraced and firmly pinched therebetween, the contacts 2 and 3 pierce through the insulator 4c and have their leading ends inserted into contact insertion holes 1c bored in the connector cover 1b so as to conform to the arrangement of the contacts 2 and 3. In this state, lock means 1e provided on the opposite ends of one of the connector substrate 1a and the connector cover 1b and lock means 1f provided on the opposite ends of the other are brought into male-to-female engagement with each other at positions outside the opposite lug portions of the flat cable, with the result that the connector substrate 1a and the connector cover 1b are integrally united with each other. In this manner, the connector 1 is firmly attached to the connector-fitting area 4d of the flat cable 4 and the conductors Sa, Sb, G, Ga and Gb for signal and earthing are kept connected to each other.

The aforementioned connecting mechanism among the contacts 2 and 3, connector cover 1b and connector substrate 1a is a mere example and may be modified.

By using the connecting mechanism as described above, preparing a connector which has the contacts 2 and 3 arranged as shown in FIGS. 1 to 4, allowing the sharp prongs 2a and 3a of the contacts 2 and 3 to be pierced through the insulator 4c of the cable 4, and allowing the U-shaped slots 2b and 3b of the contacts 2 and 3 to permit press-in of and catch hold of the conductors Sa and Sb for signal and the conductors G, Ga and Gb for earthing respectively to obtain pressure connection, two-directional signal lines of various patterns as described afterwards can be formed on the opposite ends of the flat cable.

In relation to the aforementioned description, the constructions peculiar to the embodiments shown in FIG. 1 to FIG. 4 will be described. In conjunction therewith, FIGS. 5 to 7 corresponding to the embodiment shown in FIG. 3, and FIG. 8 corresponding to the embodiment shown in FIG. 4 should be referred to.

In the embodiments shown in FIGS. 1 and 3, each of the perforated conductors having one or two perforations 5 is disposed between imperforate conductors, with the perforations in alignment with one another. In the embodiment shown in FIG. 2, each of adjacently paired perforated conductors are disposed between imperforate conductors with the perforations of each paired perforated conductors arranged so that the perforations snugly communicate with each other to form a large perforation 5. The large perforations in the perforated conductors are in alignment with one another. In any of these embodiments, the perforated conductors are used as conductors for signal and the imperforate conductors as conductors for earthing.

To be more specific, in any of the embodiments shown in FIGS. 1 to 3, the conductor is separated across the perforation 5 into a conductor segment 4a which extends as the conductor Sa for signal toward one end of the flat cable 4 and a conductor segment 4b which extends as the conductor Sb toward the other end of the flat cable 4. The conductor segment 4a is caught by and connected with part of one contact 2 for signal which pierces through the insulator of the flat cable at the terminal on the perforation side to form a one-directional signal line and, at the same time, the conductor segment 4b is caught by and connected with part of another contact 2 for signal which pierces through the insulator of the flat cable at the terminal on the perforation side to form the other-directional signal line. Therefore, the contacts 2 for signal are orderly opposed across the perforations 5.

Each of the embodiments shown in FIGS. 1 to 3 forms different signal lines on one and the other ends of the flat cable 4 and, at the same time, forms a common earthing line used for both the one-side signal line of the conductors Sa for signal and the other-side signal line of the conductors Sb which are formed on the flat cable 4 by causing each of the imperforate conductors to be adjacent to the opposite sides of each of the conductors Sa and Sb for signal (FIGS. 1 and 3) or to be adjacent to one side of each of the conductors Sa and Sb for signal (FIG. 2), causing the contacts 3 for earthing provided on the connector 1 to pierce through the insulator of the imperforate conductors between the perforations, and causing the contacts 3 to catch hold of and connect the conductors for earthing. Symbol *G* denotes a common conductor

for earthing constituting the aforementioned earthing line.

The arrangement of the perforated and imperforate conductors described with reference to the embodiments shown in FIGS. 1 to 3 should not be applied to all conductors of the flat cable. Optionally, part of the conductor for signal may be used as a conductor for earthing as occasion demands. Further, a plurality of aligned perforations per conductor may be formed in the conductors of the embodiments shown in FIGS. 1 and 2.

In the connector-fitting area 4d having a plurality of perforations aligned in the direction of the length of the conductor, one and the other ends of the perforations do not mean any end across which the perforations are disposed.

FIG. 3 shows an example of the flat cable connecting system according to the present invention, which involves the fundamental idea of the embodiment shown in FIG. 1, has two perforations per conductor formed in alignment with each other, and will be described hereinafter with reference to FIGS. 5A to 5E, 6 and 7.

As illustrated, perforations 5 constituting one group are aligned in the direction of the width of the flat cable and perforations 5 constituting the other group are aligned in parallel to the one group of perforations. Between the two groups of perforations 5 is interposed an earth bus plate 3A from which earthing contacts 3 rise in zigzag arrangement in the direction of the width of the flat cable. The earthing contacts 3 in one row catch hold of and connect the imperforate conductors (earthing conductors *G*) to form an earthing line and the earthing contacts 3 in the other row catch hold of and connect isolated portions 4f of the perforated conductors disposed between the opposed perfforations 5 and disconnected from both ends of the flat cable. The isolated portions 4 of the perforated conductors in the embodiment of FIG. 3 have nothing to do with formation of either a signal line or an earthing line. This will be better understood from FIG. 5E corresponding to FIG. 3.

When an optional signal conductor, such as a conductor composed of conductor segments Sa and Sx in FIG. 3 or FIG. 7, has a single perforation 5 without forming a perforation 5X shown by chain lines in FIG. 3 to allow the conductor segment Sx to extend over the position of an earthing contact 3X and the extended terminal of the conductor segment Sx is caught by and connected with the earthing contact 3X, it is possible to short-circuit the earthing contact 3X and a signal contact 2X. That is to say, all other earthing contacts 3 and all earthing conductors *G* connected thereto under the application of an electric current by means of the common earth bus plate 3A are connected to the conductor segment Sx (a common earth bus bar) through the earthing contact 3X, with the result that lump ground connection can be obtained through the contact 2X (a common earthing contact) which is to be a signal contact if the perforation 5X is formed in the conductor segment Sx. Thus, a lump ground connection mechanism can be formed by suitably selecting one of the signal conductors, perforating a single perforation in the selected conductor to be divided into conductor segments Sa and Sx, and connecting the conductor segment Sx and the earthing contact 3X to utilize the corresponding signal conductor segment and signal contact respectively as a common earthing bus bar and a common earthing contact. Therefore, the earthing contacts 3 arranged in a row on the intrinsically isolated portions 4f of the perforated conductors can advantageously be used when the aforementioned lump ground connection is required to be formed. Further, a concrete example of the connector and the connection mechanism adopting the lump ground connection with the selected earthing contact 3X, common earthing contact 2X and common earthing conductor Sx utilized is clearly shown in FIG. 7.

Furthermore, the embodiment shown in FIG. 3 is provided with an auxiliary earthing contact 3y which is disposed on the end of the common earth bus plate 3A and not connected to any of the conductors of the flat cable. This auxiliary earthing contact 3y is used, as shown in FIG. 6, by connecting the same to a separate conductor Gz as a common earth bus bar to thereby form lump ground connection for a printed board etc. The common earth bus bar Gz is passed through a path 1j formed in the inner surface of the cover 1b as shown in FIG. 5D and guided out of the connector. It goes without saying that the auxiliary earthing contact 3y may be applied to the embodiment of FIG. 1, 2 or 4 and that either one or both of the common earth bus bars Gz and Sx may be used, as occasion demands, in order to form lump ground connection.

The construction peculiar to the embodiment schematically shown in FIG. 4 will be described with reference to the connector and connection mechanism shown in corresponding FIGS. 8A and 8B.

In FIG. 4, a plurality of adjacent conductors are provided one each with perforations 5, whereby the same object as that of the embodiment shown in FIG. 3 is attained. To be specific, the perforations 5 in the adjacent conductors are shifted in position in the direction of the length of the conductors so as not to be exactly opposed to each other and the perforations 5 form as a whole zigzag arrangement. Each of the perforations divides the conductor 4e into a conductor segment Sa or Ga and a conductor segment Gb or Sb. This

embodiment differs from the embodiments shown in FIGS. 1 to 3 in the aspect that this embodiment has all conductors perforated therein. One of the adjacent conductors is divided by the perforation 5 into the conductor segments Sa and Gb, and the conductor segment Sa on the left hand in FIG. 4 is caught by and connected with a signal contact 2 and the conductor segment Gb on the right hand in FIG. 4 is caught by and connected with an earthing contact 3, whereas the other of the adjacent conductors is also divided by the perforation 5 into the conductor segments Ga and Sb, and the conductor segment Ga on the left hand in FIG. 4 is caught by and connected with an earthing contact 3 and the conductor segment Sb on the right hand in FIG. 4 is caught by and connected with a signal contact 2. That is to say, the conductor segments Sa and Ga on the left hand and the conductor segments Gb and Sb on the right hand in FIG. 4 are respectively arranged alternately in the direction of the width of the flat cable.

With the arrangement described above, different signal lines are formed on one and the other sides of the flat cable 4 as separated by the perforations 5 with the connector-fitting area as the boundary and simultaneously earthing lines adjacent to the signal lines are formed on both ends of the flat cable 4. In other words, the one-directional signal line and the other-directional signal line, which are formed on one conductor in the embodiments shown in FIGS. 1 to 3, are formed on the adjacent conductors in an alternate manner. The earthing conductors are similarly arranged.

It is noted that in the embodiment of FIG. 4 the arrangement patterns of the signal and earthing contacts 2 and 3 correspond to those of the signal and earthing conductors. Similarly to the embodiment of FIG. 3, an imperforate signal conductor is adopted in the embodiment of FIG. 4 to thereby enable the imperforate conductor to be used as a common earth bus bar and a signal contact connected with the imperforate conductor to be used as a common earth contact.

The connection system shown in FIG. 8 corresponding to FIG. 4 is the same as that shown in FIGS. 5 to 7 corresponding to FIG. 3, except for the arrangement of the signal contacts 2. The pattern of FIG. 4 may be adapted for part or all of the conductors in the flat cable. Further, in the embodiment of FIG. 4, two or more perforations 5 may be formed in each of the conductors.

According to the present invention, as described above, it is possible to form two-directional signal lines different from each other on one and the other ends of a single strap of flat cable by attaching a single connector to the midway portion of the flat cable in the direction of the length thereof. The present invention is thus effective when alternate use of the signal conductors and the earthing conductors is required.

When the signal and earthing conductors are alternately arranged in a single strap of flat cable according to the prior art system, the number of the signal conductors becomes one half the total number of the conductors in the flat cable. According to the present invention, however, since it is possible to form alternate signal and earthing lines on each end of a flat cable, the same results as in the case of using all conductors in a strap of flat cable as signal lines can substantially be obtained.

According to the present invention, desired patterns of signal and earthing lines can freely be formed on both ends of a flat cable by combining patterns of perforations and corresponding patterns of arrangements of contacts of a connector.

Although it has heretofore been necessary to prepare two straps of flat cables, a single strap of flat cable having a prescribed pattern of perforations will suffice in the present invention. This reduces to one half not only the cable cutting work but also the connector connecting work and particularly makes it considerably easy to position the flat cable relative to the connector and its contacts. In comparison with the case where two straps of flat cables are positioned as thrusting each other relative to a single connector, the present invention makes it easier to position a flat cable and a connector relative to each other to thereby ensure the connection between the flat cable and the connector with high accuracy. Further, since not a system of dividing a flat cable into two segments but a system of dividing a conductor into two segments is adopted in the present invention, the connector connecting work is very simplified and highly reliable connection can be expected.

In case where two straps of flat cables are used and connected to a connector, when a tension force is exerted onto one end of one of the flat cables, the one flat cable is likely to be shifted from the other flat cable to thereby lower the reliability of connection. In the present invention using a single strap of flat cable, no such adverse phenomenon arises due to relative reinforcement of both ends of the flat cable and, therefore, reliable and stable connection between the flat cable and the connector can be maintained.

The present invention makes it possible to form signal lines and earthing lines adjacently to each other while securing a desired number of signal lines within a small area without either increasing the place on which a connector is installed or bringing about complexity of a connection mechanism and, therefore, can advantageously be carried out in completing a number of signal lines with a multiple core flat cable and particularly in forming a circuit

capable of preventing occurrence of cross talk or noise between the signal lines.

FIG. 11 through FIG. 14 show still another embodiment of the present invention, which is provided with positioning means for the connector substrate 1a, connector cover 1b and flat cable 4 and will be described hereinafter.

The connector cover 1b is provided with rising walls 1k which are disposed along the lugs of the multiple core flat cable 4 to regulate the width of the flat cable and with conductor-aligning grooves 1l which are formed in the inner wall surface (cable attachment surface) between the rising walls 1k at the same pitch as that of the conductors. The conductor-aligning grooves 1l are arranged in parallel to each other to form as a whole a wave. The inner wall of the connector cover 1b forming therein the conductor-aligning grooves 1l is provided with projecting keys 8. Preferably, a plurality of projecting keys 8 are formed so as to correspond to the perforations 5 and, in pressure contact of the flat cable between the connector cover 1b and the connector substrate 1a, are inserted into the perforations 5 and held in that state after the pressure contact. Since the perforations 5 for dividing the conductors 4e are rectangular when seen from its top plan view, as illustrated, the projecting keys 8 to be inserted into the perforations 5 are preferably formed in a rectangular shape so as to conform to the shape of the perforations 5. Each of the projecting keys 8 has at least a height large enough to project downwardly from the lower surface of the flat cable. In a prefferred embodiment, the keys 8 pass through the perforations 5 in the flat cable 4 and have their respective leading ends engaged in positioning apertures 9 which are bored in the surface of the connector substrate 1a from which the contacts 2 and 3 are protruded upwardly. That is to say, the positioning apertures 9 are bored so as to communicate with the perforations 5 and admit therein the projecting keys 8. Relative positioning among the connector substrate, connector cover and flat cable can be established when the projecting keys 8 are inserted into the positioning apertures 9 through the perforations 5. Optionally, the keys 8 may be formed to be tightly fitted in the positioning apertures 9, thereby integrally uniting the connector substrate and the connector cover with each other or may be formed to be hooked in the inner walls of the positioning apertures 9.

It goes without saying that the positioning keys 8 may be omitted from the inner wall surface of the connector cover 1b forming therein the conductor-aligning grooves 1l and instead that such positioning keys 8 may be formed, in place of the positioning apertures 9, on the surface of the connector substrate 1a from which the contacts 2 and 3 project upwardly. In this case, the positioning keys 8 pass through the perforations 5 from below the flat cable 4 and are fitted in the conductor-aligning grooves of the connector cover 1b.

Even a flat cable having a large width tends to warp at its intermediate portion. Such tendency can be eliminated by inserting and fitting the projecting keys 8 into the perforations 5 formed in the intermediate portion of the flat cable, thereby enabling the flat cable in a flattened state to undergo pressure connection. Therefore, the present invention can effectively cope with the tendency of increase in number of cores, i.e. increase in width of a flat cable, and ensure highly reliable pressure connection.

Thus, the present invention functions to indicate the pressure connection position relative to the flat cable, enables the connector to be attached and connected to a proper position, maintains fitting of the keys 8 in the perfforations 5 after the pressure connection, exhibits a sufficient force against a tension force exerted in the axial direction of the conductors, and can appropriately maintain the pressure connection state.

CLAIMS

1. A flat cable connecting system comprising pinching a multiple core flat cable between a connector cover and a connector substrate having contacts to cause said contacts to pierce through an insulator of said multiple core flat cable and, in conjunction therewith, to catch hold of and electrically connect conductors within said insulator of said multiple core flat cable, which system comprises forming in said insulator perforations for dividing said conductors into conductor segments extending in one direction and conductor segments extending in the other direction, and causing different signal contacts of said connector substrate to catch hold of and electrically connect the respective conductor segments at their terminals on the perforation sides, thereby forming different signal lines with said perforations as boundaries.

2. A flat cable connecting system comprising pinching a multiple core flat cable between a connector cover and a connector substrate having contacts to cause said contacts to pierce through an insulator of said multiple core flat cable and, in conjunction therewith, to catch hold of and electrically connect conductors within said insulator of said multiple core flat cable, which system comprises forming in said insulator perforations for dividing said conductors into conductor segments extending in one direction and conductor segments extending in the other direction, and causing signal contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said one direction at their terminals on the perforation sides and simultaneously

causing earthing contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said the other direction at their terminals on the perforation sides, thereby forming signal lines and earthing lines with said perforations as boundaries.

3. A flat cable connecting system comprising pinching a multiple core flat cable between a connector cover and a connector substrate having contacts to cause said contacts to pierce through an insulator of said multiple core flat cable and, in conjunction therewith, to catch hold of and electrically connect conductors within said insulator of said multiple core flat cable, which system comprises forming in said insulator perforations for dividing said conductors into conductor segments extending in one direction and conductor segments extending in the other direction so that the perforated conductors are disposed adjacently to imperforate conductors, causing signal contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said one and the other directions at their terminals on the perforation sides to thereby form signal lines, and simultaneously causing earthing contacts of said connector substrate to catch hold of and electrically connect said imperforate conductors adjacent to said perforated conductors to thereby farm earthing lines.

4. A flat cable connecting system comprising pinching a multiple core flat cable between a connector cover and a connector substrate having contacts to cause said contacts to pierce through an insulator of said multiple core flat cable and, in conjunction therewith, to catch hold of and electrically connect conductors within said insulator of said multiple core flat cable, which system comprises forming in said insulator perforations for dividing said conductors into conductor segments extending in one direction and conductor segments extending in the other direction so that said perforations are arranged zigzag, causing signal contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said one direction and earthing contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said the other direction of one of the adjacent conductors, and simultaneously causing earthing contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said one direction and signal contacts of said connector substrate to catch hold of and electrically connect said conductor segments extending in said the other direction of the other of the adjacent conductors, thereby forming alternate signal lines and earthing lines on the respective conductor segments extending in said one and the other directions.

5. A flat cable connecting system according to claim 2, wherein said earthing contacts caused to catch hold of and electrically connect said conductor segments extending in said the other direction at their terminals on the perforation sides to thereby form earthing lines rise from a common earth bus plate.

6. A flat cable connecting system according to claim 3, wherein said earthing contacts caused to catch hold of and electrically connect said imperforate conductors adjacent to said perforated conductors to thereby form earthing lines rise from a common earth bus plate.

7. A flat cable connecting system according to claim 4, wherein said earthing contacts caused to catch hold of and electrically connect said conductor segments extending in said one and the other directions to thereby form earthing lines rise from a common earth bus plate.

8. A flat cable connecting system according to claim 1, wherein said connector cover is provided with positioning keys which project from said connector cover and are to be inserted into said perforations, and said contacts are caused to catch hold of and electrically connect said conductor segments with said positioning keys inserted into said perforations.

9. A flat cable connecting system according to claim 2, wherein said connector cover is provided with positioning keys which project from said connector cover and are to be inserted into said perforations, and said contacts are caused to catch hold of and electrically connect said conductor segments with said positioning keys inserted into said perforations.

10. A flat cable connecting system according to claim 3, wherein said connector cover is provided with positioning keys which project from said connector cover and are to be inserted into said perforations, and said contacts are caused to catch hold of and electrically connect said conductor segments and said imperforate conductors with said positioning keys inserted into said perforations.

11. A flat cable connecting system according to claim 4, wherein said connector cover is provided with positioning keys which project from said connector cover and are to be inserted into said perforations, and said contacts are caused to catch hold of and electrically connect said conductor segments with said positioning keys inserted into said perforations.

12. A flat cable connecting system according to claim 8, wherein said connector substrate is provided with positioning apertures, and said positioning keys pass through said perforations and have their respective leading ends engaged in said positioning apertures.

13. A flat cable connecting system according to claim 9, wherein said connector sub-

strate is provided with positioning apertures, and said positioning keys pass through said perforations and have their respective leading ends engaged in said positioning apertures.

14. A flat cable connecting system according to claim 10, wherein said connector substrate is provided with positioning apertures, and said positioning keys pass through said perforations and have their respective leading ends engaged in said positioning apertures.

15. A flat cable connecting system according to claim 11, wherein said connector substrate is provided with positioning apertures, and said positioning keys pass through said perforations and have their respective leading ends engaged in said positioning apertures.

16. A flat cable connecting system substantially as hereinbefore described with reference to the accompanying drawings.

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